

CLAIMS

What is claimed is:

1. A composition, comprising:

- a) a core having an empirical formula



wherein: x is greater than about 0.1 and equal to or less than about 1.3,

y is greater than about 0.0 and equal to or less than about 0.5,

z is greater than 0.0 and equal to or less than about 0.2,

M' is at least one member of the group consisting of sodium,

10 potassium, calcium, magnesium and strontium, and

M'' is at least one member of the group consisting of cobalt,

iron, manganese, chromium, vanadium, titanium,

magnesium, silicon, boron, aluminum and gallium; and

- b) a coating on the core having a greater ratio of cobalt to nickel than the

15 core.

2. The composition of Claim 1, wherein M'' includes cobalt.

3. The composition of Claim 2, wherein y is in a range of between about 0.1 and about 0.5.

4. The composition of Claim 3, wherein y is about 0.1.

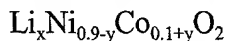
- 20 5. The composition of Claim 3, wherein y is about 0.2.

6. The composition of Claim 2, wherein M' includes magnesium.

7. The composition of Claim 6, wherein M'' further includes boron.

8. The composition of Claim 6, wherein M'' further includes manganese.
9. The composition of Claim 6, wherein the sum of x and z equals about one.
10. The composition of Claim 1, wherein the ratio of cobalt to nickel increases as a gradient from the core to an outer surface of the coating.

- 5 11. The composition of Claim 1, wherein the core has an empirical formula



wherein: x is greater than about 0.1 and equal to or less than 1.3, and
y is greater than zero and equal to or less than about 0.4.

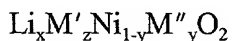
12. The composition of Claim 1, wherein the core has an empirical formula



wherein: y is greater than 0.0 and equal to or less than about 0.4,
v is greater than about 0.0 and equal to or less than about 0.4, and
B is at least one member of the group consisting of manganese,
boron, aluminum and gallium.

- 15 13. A method of forming a composition, comprising the steps:

- a) drying a water solution of LiNO_3 and $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ in which a core material is immersed, said core material having an empirical formula



wherein: x is greater than about 0.1 and equal to or less than about 1.3,
y is greater than about 0.0 and equal to or less than about 0.5,
z is greater than about 0.0 and equal to or less than about 0.2,
M' is at least one member of the group consisting of sodium,
potassium, nickel, calcium, magnesium and strontium, and
M'' is at least one member of the group consisting of cobalt,

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iron, manganese, chromium, vanadium, titanium,
magnesium, silicon, boron, aluminum and gallium,
to thereby form a precursor coating on said core material; and
b) calcining the precursor coating, thereby forming the composition.

- 5 14. The method of Claim 13, wherein the stoichiometric ratio of LiNO_3 to $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ is in a range of between about 0.0 and about 1.2.
15. The method of Claim 14, wherein the precursor coating is calcined by heating the coating to a temperature in a range of between about 500 and about 900°C for a period of time in a range of between about 0.2 and about 12 hours.
- 10 16. The method of Claim 15, wherein the precursor coating is calcined by heating the coating and the core material at a rate in a range of between about 5°C and about 100°C per minute to a temperature in a range of between about 300°C and about 500°C, which temperature then is maintained for a period of time in a range of between about 0.2 hours and about 4 hours, and then heating the precursor coating and the core material at a rate of between about 5°C and about 50°C per minute to a temperature of between about 600°C and about 900°C, at which temperature the coating is maintained for a period of time in a range of between about 0.2 and about 12 hours.
- 15 17. The method of Claim 13, wherein the core material includes $\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$.
- 20 18. The method of Claim 13, wherein the core material includes $\text{Li}_{1.1}\text{Ni}_{0.87}\text{Co}_{0.1}\text{B}_{0.03}\text{O}_2$.
19. The method of Claim 13, where the core material includes $\text{Li}_{1.07}\text{Mg}_{0.03}\text{Ni}_{0.85}\text{Co}_{0.1}\text{Mn}_{0.05}\text{O}_2$.

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20. The method of Claim 13, wherein the amount of coating formed on the core material is greater than 0.0 mole percent and equal to or less than about 15.0 mole percent of the composition.
21. The method of Claim 13, wherein the amount of coating formed on the core material is greater than 5.0 mole percent and equal to or less than about 15.0 mole percent of the composition.
22. The method of Claim 13, wherein the amount of coating formed on the core material is greater than 5.0 mole percent and equal to or less than about 10.0 mole percent of the composition.
23. A lithium battery having a cathode that includes a composition, said composition including particles, comprising:
- a) a core having an empirical formula
- $$\text{Li}_x\text{M}'_z\text{Ni}_{1-y}\text{M}''_y\text{O}_2$$
- wherein: x is greater than about 0.1 and equal to or less than about 1.3,
- y is greater than about 0.0 and equal to or less than about 0.5,
- z is equal to or greater than about 0.0 and equal to or less than about 0.2,
- M' is at least one member of the group consisting of sodium, potassium, nickel, calcium, magnesium and strontium, and
- M'' is at least one member of the group consisting of cobalt, iron, manganese, chromium, vanadium, titanium, magnesium, silicon, boron, aluminum and gallium; and
- b) a coating having a greater ratio of cobalt to nickel than the core.